The applicant will now address each of the issues raised in the outstanding Office Action.

Objections

The drawings were objected to under 37 C.F.R. § 1.83(a), for failing to show every feature of the invention specified in the claims. More specifically, the Examiner asks to see the full H-bridges, two photo sensors, sensing and non-sensing regions of the commutation encoder, and phases excited. (See Paper No. 5, page 2.) The applicant refers the Examiner to Fig. 5A and Fig. 5B of the application as an exemplary embodiment including all the specified elements. There are five H-bridges shown in Fig. 5A. More specifically, one H-bridge includes switches Q_1, Q_2, Q_3 and Q_4, and a coil. The coupling of these elements creates an "H" like structure. Switches Q_1, Q_2, Q_3 and Q_4 may be implemented using power transistors.

Each phase has two photo sensors coupled to them, therefore there are ten photo sensors in the Figures. More specifically, PA1 and PA2 exemplify two photo sensors coupled to A Phase.

Examples of sensing and non-sensing regions can be seen on the circular object located on the lower right of Fig. 5B. There are three indentations on the circumference of the circle. Two of them can be plainly seen, and the third indentation is covered by photo sensors PA1, PB1 and PC1. The indented region exemplifies the sensing region, and the non-indented region exemplifies the non-sensing region. Fig. 5B shows photo sensors PA1, PB1

and PC1 in a sensing region, and the other photo sensors in a non-sensing region.

Finally, Fig. 5A is an example illustrating three phases excited. Please refer to switches Q1, Q4, Q5, Q8, Q9 and Q12. All these switches are closed allowing current to flow through the coil, and making phases A, B and C excited. This coincides with photo sensors PA1, PB1 and PC1 lying within a sensing region.

In view of the foregoing remarks, the applicant respectfully submits that the claimed features are supported by the drawings. Accordingly, the applicant respectfully requests that the Examiner withdraw this objection.

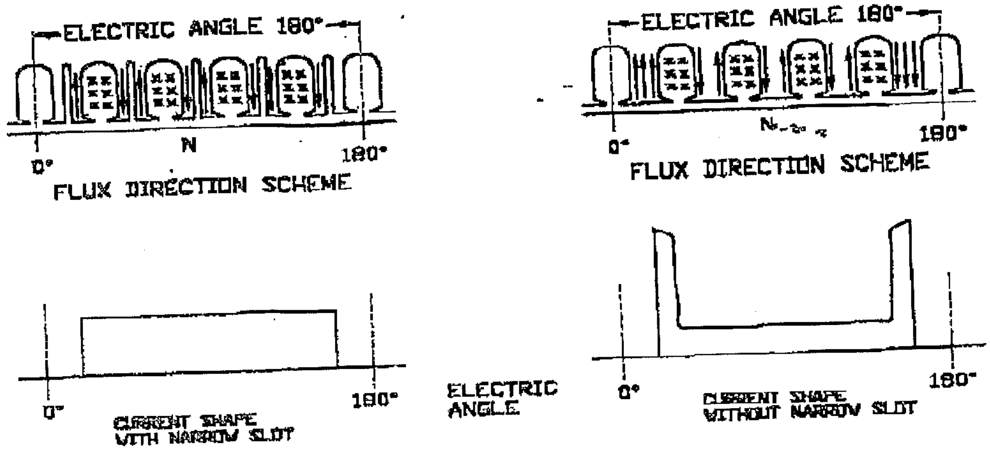
Rejections under 35 U.S.C. § 112

Claims 1-4 stand rejected as being unpatentable under 35 U.S.C. § 112, ¶ 1 as containing subject matter that was not described in the specification in such a way as to reasonably convey to one skilled in the art that the inventor, at the time the application was filed, had possession of the claimed invention. The applicants respectfully request that the Examiner reconsider and withdraw this ground of rejection in view of the following.

The Examiner asks what H-bridges are doing in the stator and what the advantages are to using them. (See Paper No. 5, page 2). An exemplary H-bridge can be seen in Fig. 5A of the application. The H-bridge is represented by switches, e.g., transistors, Q1 through Q4, and a winding.

The H-bridge is one component used to excite the different phases. When a photo sensor enters the sensing region, it will activate the switches it is connected to and excite the corresponding phase. An exemplary utilization of the H-bridges is given in the application on page 8, lines 5-31. In addition the H-bridge configuration gives the DC motor of the present invention clockwise and counterclockwise capabilities and bi-directional operation. (See Page 10, lines 18-27). In view of this explanation and reference to the specification, the applicant respectfully asks that the Examiner reconsider and withdraw the rejection under 35 U.S.C. § 112, ¶ 1.

Next, the Examiner asks what the cancel phenomenon is and why it would be good to remove it. The Examiner also asks why narrow slots would remove this phenomenon. (See Paper No. 5, page 2). When the coils of each phase are electrified, a collision of magnetic flux is generated, lowering the efficiency of the motor. (Page 10 lines 32-34 and page 11, line 1). These issues will be addressed with reference to the following figures:



THE EFFECT OF CANCEL ELIMINATION SLOT

As shown in the picture above and known in the art, cancel elimination phenomenon occurs when the coils are electrified. Flux flows through the stator in opposite directions and each collides with the other. This is shown in the exemplary stator in the upper right hand corner of the above figure. The flux traveling in opposite directions through the same piece of metal causes the cancel elimination effect and creates the valley-like current shape shown in the lower right hand corner. The exemplary stator of the upper right hand corner shows the stator with the narrow slots. This provides separate paths for the flux and creates the rectangular current shape shown in the lower left hand corner. In view of this explanation, the applicant respectfully asks that the Examiner reconsider and withdraw the rejection under 35 U.S.C. § 112, ¶ 1.

Claim 4 stands rejected as being unpatentable under 35 U.S.C. § 112, ¶ 2 as failing to particularly point out and distinctly claim the invention. The applicant

respectfully requests that the Examiner reconsider and withdraw this ground of rejection in view of the following.

The Examiner asks if it is possible to have all phases inexcited, what would happen if the number of inexcited phases is greater than the desired number, and why it is good to have inexcited phases. (See Paper No. 5, page 3). Please refer to Fig. 5A and Fig. 5B for an exemplary driving circuit of a 5-phase motor, and a commutation encoder and photo sensors of a 5-phase 6-polarity motor of the present invention. For all the phases to be inexcited, the ring shaped plate that determines the sensing and non-sensing regions on the commutation encoder should remain uncut (See page 5, lines 28-31.) This would not be desirable because none of the phases would ever be excited since the photo sensors turn the half H-bridge on and off, and the H-bridges control excited or inexcited state of the phases. (See page 2 lines 24-26.) In addition, the sensing region and the non-sensing regions have been made so that the number of excited phases and inexcited phases always remain constant. (See page 8 lines 32-34 and page 9, lines 1-8.) Finally, inexcited phases advantageously allow for advanced commutation. In the process of converting electric energy into mechanical energy by the motor, the timing of the stator coil to be excited is delayed from the timing of the passive magnetic flux of the rotor. Advanced commutation makes these timings coincide. (See page 9, lines 29-34 and page 10, line 1.) More inexcited phases give the motor more time to allow advanced commutation. (See page 12, lines 19-23.) In light of this explanation and reference to the specification, the applicant respectfully asks that

the Examiner reconsider the rejection under 35 U.S.C. § 112, ¶ 2.

Rejections under 35 U.S.C. § 103

Claims 1-4 stand rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 4,882,524 (hereafter referred to as "the Lee patent"), in view of U.S. Patent No. 2,903,610 (hereafter referred to as "the Bessiere patent"), and in view of U.S. Patent No. 5,982,067 (hereafter referred to as "the Sebastian patent"). The applicant respectfully requests that the Examiner reconsider and withdraw this ground of rejection in view of the following.

Independent claim 1 is not rendered obvious by the Lee, Bessiere and Sebastian patents because these patents, either taken alone or in combination, fail to teach or suggest (1) a constant-power brushless DC motor, and (2) a stator wound in parallel by phases and polarities, each of the winding coils of the stator not connected with one another. Claim 1, as amended, is reprinted below with the above-identified distinguishing features depicted in bold typeface:

✓ See Lee's title!

> **A constant-power brushless DC motor,** comprising: → Preamble ✓
>
> **a stator wound in parallel by phases and polarities and configured of n multi-phases, each of the winding coils of the stator which are not connected with one another** is connected to each of n full H-bridges, n full H-bridges are connected to a DC power supply in parallel; ? ✓

> a rotor having a predetermined number of polarities, which is required to concentrate magnetic flux on excitation area;
>
> a commutation encoder including sensing regions and nonsensing regions, the commutation encoder being externally set to one side of the shaft of the rotor; and
>
> two photo sensors set to each phase, the two photo sensors being connected to a half H-bridge of each phase, to switch the half H-bridge on and off, wherein the width of each of the sensing regions of the commutator encoder is determined to allow a phases among n phases to be excited constantly, the a photo sensors recognizing the corresponding phases excited. [Emphasis added.]

Furthermore, one of ordinary skill in the art would not have been motivated to combine and modify the references as proposed by the Examiner. combination

Claim 1 is not rendered obvious by the Lee, Bessiere and Sebastian patents because these patents neither teach, nor suggest, a constant-power brushless DC motor. Citing, Fig. 1, and column 8, lines 60-65, of the Lee patent, the Examiner posits that Lee discloses a constant power brushless DC motor. (See Paper No. 5, page 3.) This is incorrect. Fig. 6 of the Lee patent shows the combination of the torque from the three phases outputs a rippled torque. This is reiterated in the description of the figures. (See column 2, lines 53-54.) The specification also explains that the torque of conventional motors is a sinusoidal or trapezoidal torque scheme,

causing torque ripple. (See page 12, line 12-13.) The output torque of the present invention, on the other hand, is flat. More specifically, the motor of the present invention applies a partial square wave to the winding coil of each phase, allowing each phase to realize rectangular torque scheme. (See page 12, lines 14-17.) When rectangular torque schemes are added together they result in a flat output torque. This can be seen in Fig. 6 of the present application. The sum of the torque from phases A, B, C, D, and E is a constant torque. As is known in the art, torque is rotational force, therefore constant torque yields constant power. The Examiner does not rely on the Bessiere and Sebastian patents for this teaching. Accordingly, claim 1 is not rendered obvious by the Lee, Bessiere and Sebastian patents for at least this reason. Since claims 2-4 depend from claim 1, they are similarly not rendered obvious by the Lee, Bessiere and Sebastian patents.

N/C

N/C

N/C completely conclusory obscure

Further, Claim 1 is not rendered obvious by the Lee, Bessiere and Sebastian patents because these patents neither teach, nor suggest, a stator wound in parallel by phases and polarities, each of the winding coils of the stator not connected with one another. Citing, Fig. 5, and column 4, lines 5-7, of the Sebastian patent, the Examiner posits that Lee discloses a brushless DC motor with the coils connected in parallel. (See Paper No. 5, page 3.) However, the coils of a brushless DC motor connected in parallel proposed in the Sebastian patent are connected together in a "Y" configuration. (See Fig. 5 and column 4, lines 1-3.) More specifically at least three of the phases are interconnected. In contrast, as recited in claim 1,

N/C

the phases are independently wound in parallel without the interconnection. (See page 7, lines 15-18.) The Examiner does not rely on the Lee and Bessiere patents for this teaching. Accordingly, claim 1 is not rendered obvious by the Lee, Bessiere and Sebastian patents for at least this reason. Since claims 2-4 depend from claim 1, they are similarly not rendered obvious by the Lee, Bessiere and Sebastian patents.

Dependant claim 2 is not rendered obvious by the Lee, Bessiere and Sebastian patents because these patents, either taken alone or in combination, fail to teach or suggest narrow slots for the purpose of removing cancel elimination effect. Claim 2 is reprinted below with the above-identified distinguishing features depicted in bold typeface:

> The motor as claimed in claim 1, wherein **the stator has narrow slots to remove cancel phenomenon.** [Emphasis added.]

The Examiner references figure 3 and column 3, lines 7-16 of the Bessiere patent as disclosing narrow slots for the purpose of eliminating armature reaction flux on the stator. However, the present invention claims narrow slots for the elimination of the flux cancel phenomenon. Armature reaction is the interference caused between the magnetic field of the permanent magnets of a stator and the magnetic field of the coils, while the cancel phenomenon is the colliding of flux traveling in opposite directions through the stator. The Examiner does not rely on the Lee and Sebastian patents for this teaching. Accordingly, claim 2 is not rendered obvious by

the Lee, Bessiere and Sebastian patents for at least this reason.

Dependant claim 3 is not rendered obvious by the Lee, Bessiere and Sebastian patents because these patents, either taken alone or in combination, fail to teach or suggest means to create n excited phases thereby creating multiple inexcited phases. Claim 3, as amended, is reprinted below with the above-identified distinguishing features depicted in bold typeface:

> The motor as claimed in claim 1, wherein the number of phases among the n phases, which will be excited, is determined by the distance between the sensing regions, the distance between the sensing regions being determined through the following expression,
>
> **width of sensing regions**
>
> **= (2π × number of phases to be excited)/(number of polarities of rotor × number of phases of motor) (°),**
>
> the number of sensing regions in the commutation encoder being determined through the following expression,
>
> number of sensing regions
>
> =(number of polarities of rotor)/2,
>
> the distance between the photo sensors on a sensor plate being determined by the following expression,
>
> distance between photo sensors
>
> = 2π/(number of polarities of rotor × number of phases of motor) (°),
>
> among the n phases, a phases being excited but **b phases not**

being excited all the time.
[Emphasis added.]

The Examiner cites the equation in column 4, lines 27-34, of the Lee patent as disclosing the distance between the sensing regions. (See paper 5, page 4). The equation disclosed in the Lee patent neither teaches, nor suggests, means to create multiple inexcited phases. The equation disclosed in the Lee patent reads as follows:

The width of the sensing region

= (2π/the number of poles in the rotor) × (the number of phases - 1)/(the number of phases) (degrees)

On the other hand, the equation in claim 3 states:

width of sensing regions

= (2π × number of phases to be excited)/(number of polarities of rotor × number of phases of motor) (°).

The Lee patent only discloses an equation for one inexcited phase. It neither teaches, nor suggests having multiple inexcited phases. The Examiner does not rely on the Bessiere and Sebastian patents for this teaching. Accordingly, claim 3 is not rendered obvious by the Lee, Bessiere and Sebastian patents for at least this reason. Since claim 4 depends from claim 3, it is similarly not rendered obvious by the Lee, Bessiere and Sebastian patents.

Dependant claim 4 is not rendered obvious by the Lee, Bessiere and Sebastian patents because these patents, either taken alone or in combination, fail to teach or

suggest multiple inexcited phases. Claim 4 is reprinted, below with the above-identified distinguishing feature depicted in bold typeface:

> The motor as claimed in claim 3, **wherein b≥1, b corresponding to the number of phases inexcited.** [Emphasis added.]

The invention disclosed in the Lee patent does not show multiple inexcited phases. It only allows one phase to be inexcited. The Examiner cites column 5, lines 59-64 of the Lee patent as disclosing more than one inexcited phase (See paper 5, page 4), but that section of the Lee patent only discloses multiple excited phases. More specifically, it states:

> "Accordingly, the commutation encoder and photo-transistors according to the present invention becomes of 2-phase 1-exciting, 3-phase 2-exciting, 4-phase 3-exciting, 6-phase 5-exciting, … so that the n-phase (n-1)-exciting motor is construction, thereby performing the production of the multiphase bipolar brushless D.C. motor."

In all the examples listed above, including the general example, there are multiple excited phases, and one inexcited phase. The Examiner does not rely on the Bessiere and Sebastian patents for this teaching. Accordingly, claim 4 is not rendered obvious by the Lee, Bessiere and Sebastian patents for at least this reason.

Finally, one of ordinary skill in the art would not have been motivated to combine the references as proposed by the Examiner because the narrow slots disclosed in the Bessiere patent is between permanent magnets located on the stator. The motor disclosed in the Lee patent is a brushless DC motor with the permanent magnets located on the rotor. Since a motor with such permanent magnets on both the rotor and stator would not function well, one skilled in the art would not combine the two teachings.

New claims

The exemplary rotor of new independent claim 5 has empty space to help the flux flow and diminish flux-leakage. The magnetic arrangement in the rotor creates a flux concentration that creates a ratio of approximately 3:1 in differential permeability across the rotor face. The reluctance effect by flux concentration contributes significant torque at high speed, giving the motor a more constant power profile, and magnets in the embedded design do not experience powerful pole changes. Consequently, demagnetization problems are all but eliminated.

The exemplary commutation encoder of claim 5 has dual sensors per phase to eliminate the need for a divider device, the off-time of the phases at the pole-change position acts as a built in crossfire prevention interlock. A Square wave drive allows a lower frequency of PWM therefore lowering di/dt losses in the power switches, which allows the use of slower, less expensive power

switches. Lastly, by dividing the current between phases, each phase sees lower relative current, allowing higher power at low voltages and higher power density.

In new dependent claim 6, the narrow slots are used to eliminate the collision between the flux.

Conclusion

In view of the foregoing amendments and remarks, the applicant respectfully submits that the pending claims are in condition for allowance. Accordingly, the applicants request that the Examiner pass this application to issue.

Respectfully submitted,

September 4, 2001

John C. Pokotylo, Attorney
Reg. No. 36,242
Customer No. 26479
(732) 335-1222

STRAUB & POKOTYLO
1 Bethany Road
Suite 83
Hazlet, NJ 07730

CERTIFICATE OF MAILING under 37 C.F.R. 1.8(a)

I hereby certify that this correspondence is being deposited on **September 4, 2001** with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

John C. Pokotylo

Reg. No. 36,242

SEPARATE SHEET WITH MARKED-UP VERSION OF CLAIMS PER 37 C.F.R § 1.121(c)(1)(ii)

1. (AMENDED) A constant-power brushless DC motor, comprising:

a stator [which is] wound in parallel by phases and polarities and configured of n multi-phases, each of the winding coils of the stator which are not connected with one another is connected to each of n full H-bridges, n full H-bridges are connected to a DC power supply in parallel;

a rotor having a predetermined number of polarities, which is required to concentrate magnetic flux on excitation area;

a commutation encoder including sensing regions and nonsensing regions, the commutation encoder being externally set to one side of the shaft of the rotor; and

two photo sensors set to each phase, the two photo sensors being connected to a half H-bridge of each phase, to [turn on/off] switch the half H-bridge on and off, wherein the [distance between] width of each of the sensing regions of the commutator encoder is determined to allow a phases among n phases to be excited [all the time] constantly, the [a] corresponding photo sensors recognizing the a phases excited.

3. (AMENDED) The motor as claimed in claim [3] 1, wherein the number of phases among the n phases, which will be excited, is determined by the distance between the sensing regions, the distance between the sensing regions being determined through the following expression,

[distance between] width of sensing regions

$= (2\pi \times$ number of phases to be excited$)/($number of polarities of rotor $\times$ number of phases of motor$)$ (°),

the number of sensing regions in the commutation encoder being determined through the following expression,

number of sensing regions

=(number of polarities of rotor)/2,

the distance between the photo sensors on a sensor plate being determined by the following expression,

distance between photo sensors

$= 2\pi/($number of polarities of rotor $\times$ number of phases of motor$)$ (°),

among the n phases, a phases being excited but b phases not being excited all the time.